Controlled Short-Term Dermal and Inhalation Exposure to MTBE and Dibromochloromethane

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Background

- **Methyl *tert*-butyl ether (MTBE)** is added to gasoline in those parts of U.S. that are in non-compliance with National Ambient Air Quality Standards for CO during wintertime.
- Use of MTBE has provided important health benefits by reducing hazardous air pollutants.
- MTBE contamination of various U.S. drinking water sources has raised concerns about exposures and potential health effects from water usage.
- Water used for showering, bathing, or drinking can also contain disinfection byproducts (DBPs).
- Trihalomethanes (THMs) are the most common and abundant DBPs in chlorinated drinking water.
- The THM **dibromochloromethane (DBCM)** occurs as a result of chlorination where ground water contains bromide.
- Relatively little information is available on exposure to DBCM.

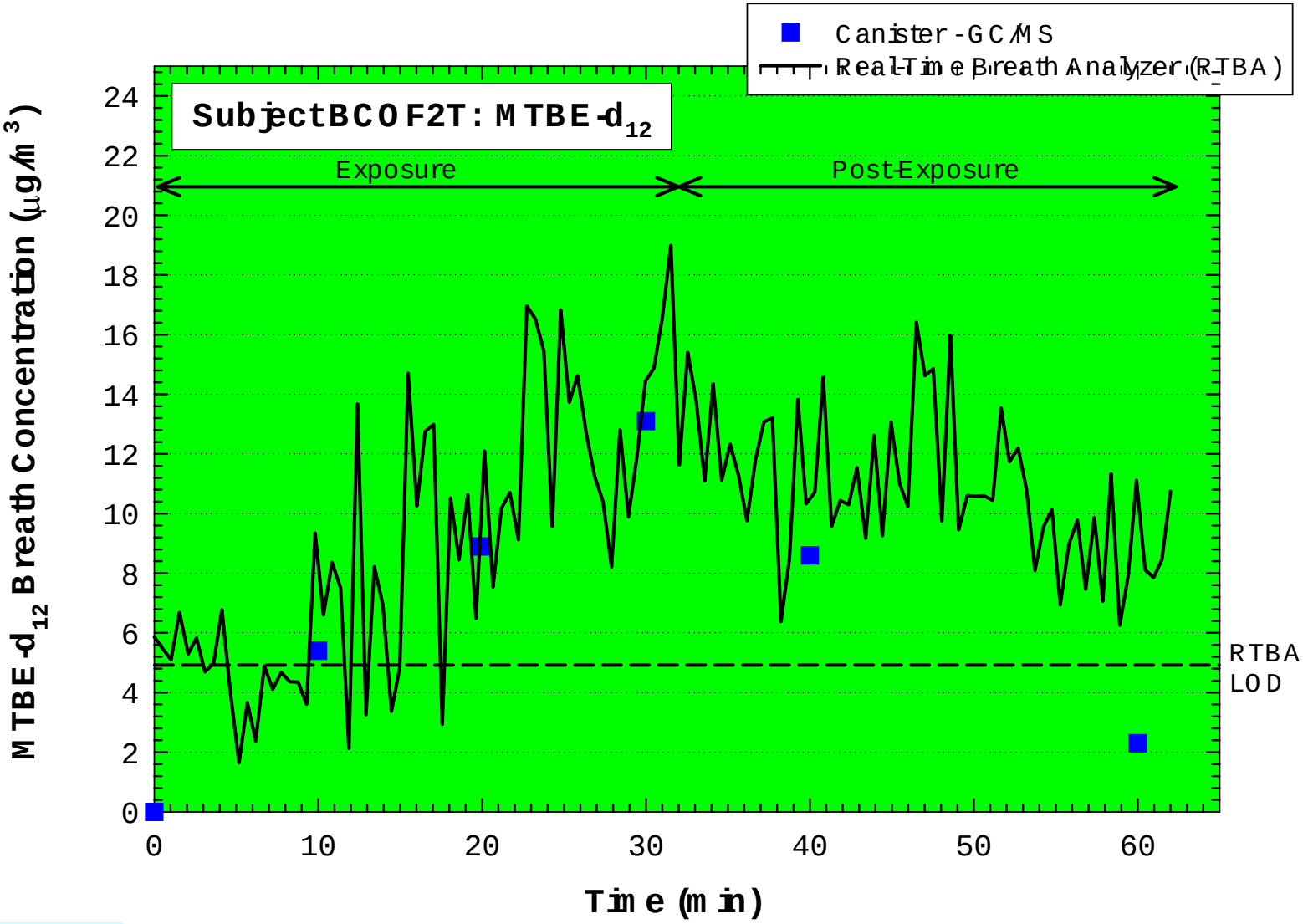
Study Objectives

- To better understand dermal and inhalation uptake and disposition of MTBE and DBCM in the human body by measuring body burden resulting from :
  - Showering or bathing exposures
  - Inhalation exposures
- Establish models for further testing and evaluation for application in population-based exposure studies

Dermal-Only Exposure to MTBE and DBCM While Bathing

- Subjects bathed in tap water containing MTBE and DBCM.
- Subjects breathed clean air through full face mask to avoid inhalation exposure to target contaminants.
- Exhaled breath was monitored continuously, every 31 sec, using real-time breath analyzer (glow discharge ionization source/ion trap mass spectrometer).
- Preliminary tests indicated that levels obtained from showering were too low to be measured reliably.

Breath MTBE-d_{12} from Dermal Exposure While Bathing



Total Exhaled MTBE Dose from Dermal Exposure While Bathing (Five Subjects)

Water Conc. (µg/L)	Water Temp. (ºC)	Bath Duration (min)	Max. Obs. Breath Conc. (µg/m^3)	Exhaled Dose[a] (µg)
150 ± 0[b]	39.5 ± 0.6	32.5 ± 1.8	13 ± 4	3.22 ± 1.23

[a] Exhaled dose values normalized to 30 min decay period.

[b] Standard deviation.

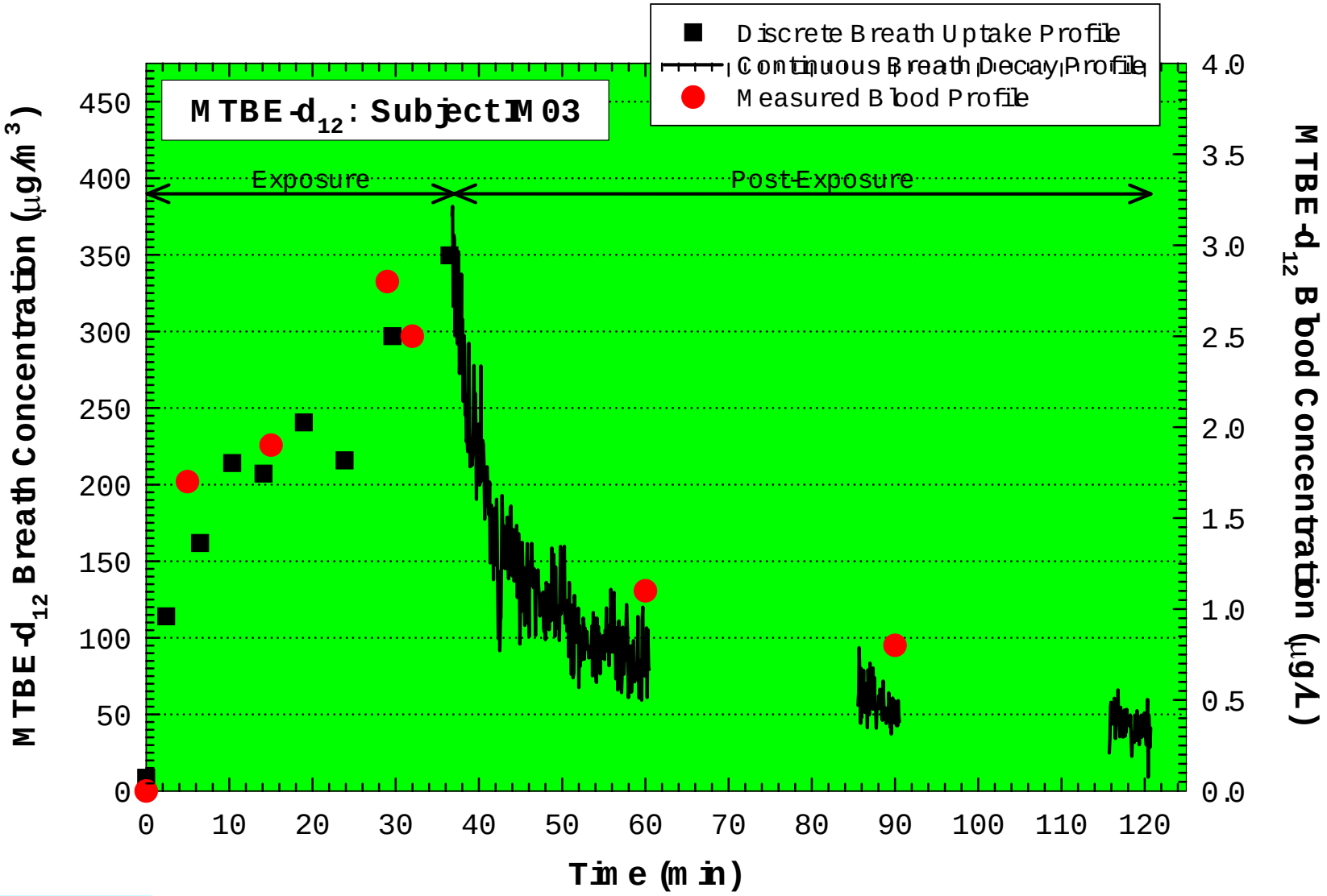
Inhalation-Only Exposure: Procedure

- Each subject wore full face mask.
- Subject inhaled known amounts of MTBE-d_{12} and DBCM in air.
- Following exposure, subject inhaled pure air.
- Exhaled breath monitored continuously during uptake and decay phases using real-time breath analyzer.
- Simultaneous blood samples drawn before, during, and after exposure.
- Blood samples analyzed separately for MTBE-d_{12} and DBCM.

Inhalation-Only Exposure: Experimental Conditions

- Seven subjects: 5 males, 2 females;
  age: 19 – 54 years; weight: 53 – 91 kg
- Air concentrations:
  MTBE-d_{12}: 2,200 µg/m^3; (540 ppbv)
  DBCM: 730 µg/m^3; (90 ppbv)
- Exposure duration: ~30 min
- Post-exposure monitoring periods:
  ~30, ~60, ~90 min

Inhalation-Only Exposure: MTBE-d_{12} Breath and Blood Uptake and Decay Profiles



Inhalation Exposure: Model Results for MTBE-d_{12}

- Uptake data for both breath and blood, as well as decay data for blood, are consistent with one-compartment model.
- Decay phase breath data consistent with two-compartment model.
- Decay residence times following inhalation are much lower than the value obtained from the dermal exposure study discussed earlier.
- Blood and breath uptake residence times are in close agreement; blood decay residence time is ~3 times greater than breath value.
- Decay residence times in breath and blood compare well with ranges of values reported by Buckley et al. and Lee et al.

Conclusions

- **Dermal Exposure:** MTBE-d_{12} breath concentration/time profiles show expected increase (exposure) and decrease (post-exposure).
- MTBE-d_{12} total exhaled dose from dermal exposure was 3.22 µg for water concentration 150 µg/L and temperature 39.5°C.
- MTBE-d_{12} (one-compartment) residence times: uptake 16.8 min; decay 52.6 min.
- **Inhalation Exposure:** Biofeedback exposure control system provided effective measurement of uptake during exposure.
- Average fraction *f* of MTBE-d_{12} exhaled unchanged was 0.29 ± 0.04, and total absorbed dose was 148.5 ± 34.3 µg (71.2 % of total dose).
- Strong correlation found between blood and breath MTBE-d_{12} uptake residence times (5.5 – 5.7 min); blood decay residence times 3x larger than breath values.
- Blood/breath ratio constant during exposure, then decreases rapidly.